Infant Behavior in a Captive Silvered Langur (*Trachypithecus cristatus*) Family

Undergraduate Research Thesis

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By
Sara Grace Lucci

The Ohio State University
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Project Advisor: Dr. W. Scott McGraw, Department of Anthropology
Project Co-Advisor: Dr. Ian Hamilton, Department of Evolution, Ecology, and Organismal Biology

Abstract

There have been few studies on the development of infant behavior in colobines. This paper seeks to understand the behavioral development of the silvered langur (*Trachypithecus cristatus*), a colobine native to Southeast Asia. The study group consisted of two adult females, a male and female infant, and the adult male father. The null hypothesis was that there would be no difference in behavior between the male and female infant. Based on previous research, predictions were that the two infants would differ in activity, sociality, and maternal interaction. Data on behavior were recorded for each individual between January and August, 2016. Proportions of observed behaviors were calculated for each individual for each day and used to generate histograms. Contrary to previous studies, the two infants showed nearly identical proportions of almost every behavior, including grooming, feeding, activity, and maternal contact. However, this may be due to maternal style, personality differences, or late onset of sexually dimorphic behaviors. These results highlight the need for further study of infant development in colobines.

Introduction

One key characteristic of primate life histories is their extended period of infant and juvenile development when compared to mammals of similar body size. This long period of dependency allows a young primate to learn the skills needed to survive as an adult, whether those skills are dietary, social, or behavioral (Jones, 2011). Therefore, the period of infancy is an important window into how primates develop various methods of survival. In the past, infant behavior was only mentioned in relation to parents or other adult conspecifics (Furuya, 1961); however, over the past few decades there has been considerable research into behaviors of infants and juveniles and their own relationships to their mothers and group members. These studies have focused primarily on cercopithecines, and while they have provided great insight into this taxonomic group, their patterns of development may be different from those of other primate taxa (Bentley-Condit, 2003). Therefore, studying the infant development of primates with different diets and social patterns is necessary to gain insight into other species.

The silvered langur (*Trachypithecus cristatus*) is an arboreal colobine native to Southeast Asia. Like some cercopithecine species, they live mainly in female-philopatric polygynous groups. Unlike cercopithecines, they have a ruminant-like stomach that allows them to digest their mainly folivorous diet, and there are markedly relaxed hierarchies among the females (Harding, 2010). These differences in silvered langurs make them an interesting species in which to study primate infant development and test conclusions derived from cercopithecine studies.

Important milestones in the development of silvered langurs have already been well-documented. When they are born, both males and females are bright orange, which contrasts sharply next to the silver coats of adults. This natal coat is thought to facilitate allomothering, so the mother can easily find her infant among the adults in times of danger. The orange color will

change to gray within five months, but the infant will not be weaned until about 18 months, and are only fully grown by five years old (Harding, 2010). Despite this previous research, there is virtually no systematic documentation of silvered langur infant behavior. Therefore, this study serves to begin to fill the gaps of our knowledge on the development of this species within the first year of life.

A breeding group of silvered langurs at the Columbus Zoo and Aquarium provides a start into the study of their behavioral development. At the beginning of this study, each of the group's two females had an infant born within 45 days of each other. This allowed multiple variables to be examined, such as infant age, infant sex, and maternal style. In addition, the group's three adults, the two mothers and the father, provide a basis of comparison for immature vs mature behaviors.

In this study, four types of behavior were considered for the infants: sociality, maternal interaction, activity, and feeding. The null hypothesis was that there would be no differences in behavior between the two infants. However, predictions for these behaviors were derived from previous research on Hanuman langurs (*Presbytis entellus*), a more commonly studied colobine, as well as several species of cercopithecines. Hanuman langurs have social and dispersal patterns similar to those of silvered langurs, and past studies have found that female infants are more sociable than males. This is understandable, because female langurs generally stay in their natal group their whole life, so selection should favor females that start forming social relationships early in life (Nikolei and Borries, 1997). Therefore, female silvered langur infants should also be more social than their male conspecifics. Previous research on Japanese macaques (*Macaca fuscata*) has indicated that male infants are more active than females and have a sharper decrease in maternal contact than females (Eaton *et al*, 1985). These findings are used to generate

predictions for this silvered langur group. Finally, there is little physical sexual dimorphism between male and female silvered langurs. There is almost no difference in coat coloring, and females are usually about 89% of the body weight of males (Furuya, 1961 and Harding, 2010). Since their body sizes are so similar, the male and female infant should have no significant difference in feeding time, which might otherwise reflect a difference in caloric needs.

Materials and Methods

The Family

There were five individuals in the family group during this study. The adult female Patty was born in 2005 and had given birth five times including to her daughter, Rey, who was born on December 1st, 2015. The other adult female, Gumby, was born in 2001 and has also given birth five times, including to her son Milo, who was born on January 11th, 2016. The fifth group member, Thai, is an adult male who was born in 2011. He is the father of both Rey and Milo and they are his first offspring.

The Study Site

Data were taken at the langurs' on-exhibit indoor and outdoor enclosures at the Columbus Zoo and Aquarium. Keepers fed the family twice a day, once in the morning before 10:00 am, and again in the afternoon around 3:00 pm. Their diet consists of a mixture of lettuces, vegetables, and non-toxic leaves.

Data Collection

Observations began on January 21st, 2015 and ended on August 13th, 2016 and took place between 10:00 am and 7:00 pm. At the beginning of each day of observations, the date and time were recorded, as well as whether the family had access to their outdoor enclosure. Data were recorded during a three-minute focal period for one individual using an ethogram created from

behaviors previously observed of the family before data collection began (Table 1). If the individual was observed engaging in a behavior at least once, that behavior was given a value of "one" for that focal period. If the behavior was not observed, it was recorded as a "zero" for that focal period (Eaton *et al*, 1985). The following behaviors comprised the ethogram (Bardi and Huffman, 2001):

- Eating: Taking vegetables or leaves into the hands and then into the mouth, masticating, and swallowing.
- Vocalization: When the individual made some manner of vocal noise, and the context of it was also recorded.
- Sleeping: A lack of movement by the individual and their eyes were closed.
- Sitting: A lack of activity but eyes were open.
- Locomotion: Movement from one point in space to another at least 1 meter away.
- Proximity: The family members that were within 1 meter of the observed individual for at least 5 seconds.
- Interaction: General behaviors that involve another family member that were not specifically found in the ethogram, such as holding one of the infants or chasing another individual.
- Grooming: The observed individual was in a grooming dyad that involved using hands and teeth to pick through the fur of a family member. Both the partner and direction of grooming were recorded.
- Cuddle: Two individuals were close together and had their arms and legs wrapped around each other, often seen during sleeping.
- Infant Behaviors:

- Nursing: The infant had its mouth on its mother's nipple.
- Ride: The infant clung to its mother's back or stomach while the mother was locomoting.

	Eat	Sleep	Sit	Locomote	Proximity	Interact	Groom	Cuddle	Nurse	Ride	Climb
Thai: 0-3 mins											
Patty: 3-6 mins											
Gumby: 6-9 mins											
Rey: 9-12 mins											
Milo: 12-15 mins											
Rest: 15-18 mins											

Table 1: A sample ethogram used to record data for each family member during their three minute focal period.

The ethogram in Table 1 was considered a "round" and 4-12 rounds were documented during each day of observations. The "Rest" period was included so that an individual's focal period was independent from that individual's subsequent focal period. Each individual was considered to be its own sample.

Results

Over the course of this study, data were collected for 43 days. The proportion of each measured behavior was calculated by counting the number of rounds per day in which that behavior was observed and dividing it by the number of rounds for that day. This yielded 43 proportions for each behavior for each family member, which were rounded to the nearest tenth and used to generate comparative histograms. In addition, descriptive statistics were calculated for each behavior for each family member.

Four types of behaviors were the focus of analysis for the infants. First, locomotion was used to measure the level of activity, and second, consuming solid foods was used for comparisons of feeding between the infants. Third, grooming was used as a measure of sociality between family members. In addition, three specific behaviors were compared for the infants in terms of their maternal interaction. Maternal contact was the sum of rounds for each infant in which they were observed being held by, groomed by, or riding on their mother. Nursing and proximity to its mother were also compared.

The Infants

The proportions of locomotor behaviors for both Rey and Milo are approximately evenly spread, although Milo does appear to have a skew to the right, which is reflected in his slightly lower average proportion of locomotion (Figure 1, Table 2).

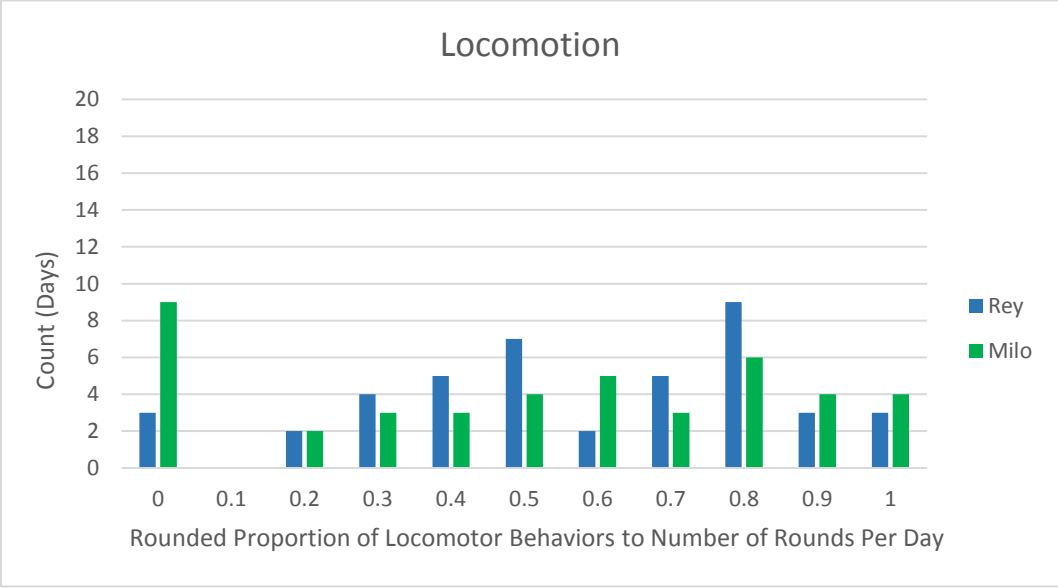

Figure 1: A comparison between Milo and Rey of their rounded proportions for rounds in which locomotor behaviors were observed to the number of rounds per day. Proportions for both are fairly evenly spread, but Milo does have a slight skew to the right.

Proportions of eating solid foods for both infants are highly skewed to the right, with an average proportion of less than 0.2 for each (Figure 2, Table 2).

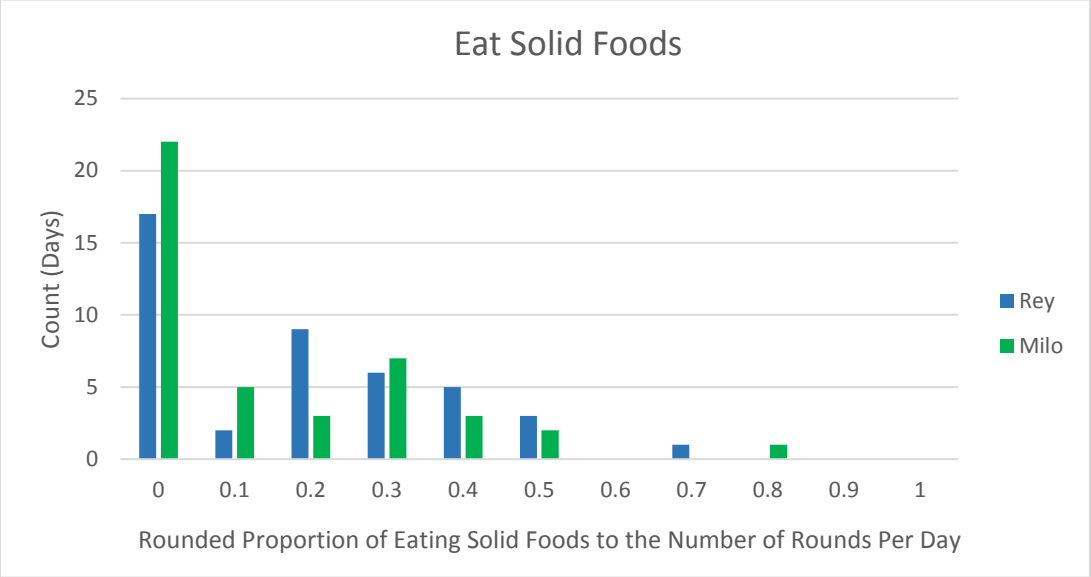

Figure 2: A comparison between Milo and Rey of their rounded proportions for rounds in which eating solid foods was observed to the number of rounds per day. Proportions for both are skewed to the right.

In addition, the two infants showed similarly low amounts of grooming behaviors, as illustrated in their histograms that have almost identical skews (Figure 3, Table 2).

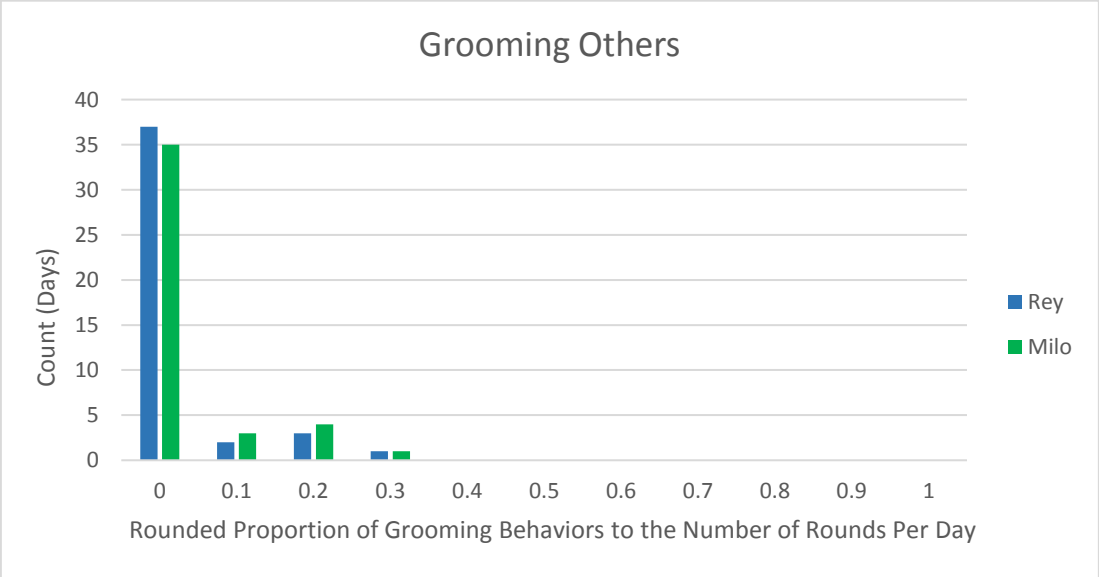

Figure 3: A comparison between Milo and Rey of their rounded proportions for rounds in which grooming behaviors were observed to the number of rounds per day. Proportions for both are highly skewed to the right.

Rey		Average (per day)
	Locomotion	0.549
	Eating Solid Foods	0.170
	Grooming Others	0.022
Milo		
	Locomotion	0.492
	Eating Solid Foods	0.131
	Grooming Others	0.026

Table 2: A table of averages for the locomotion, eating solid foods, and grooming proportions. Rey has a slightly higher average for locomotion. The averages for eating solid food and grooming are quite similar for both infants.

Both Rey and Milo have fairly high proportions of maternal contact, as shown in the slight left skew in Figure 4, but Milo has a slightly higher average proportion of maternal contact than Rey (Table 3).

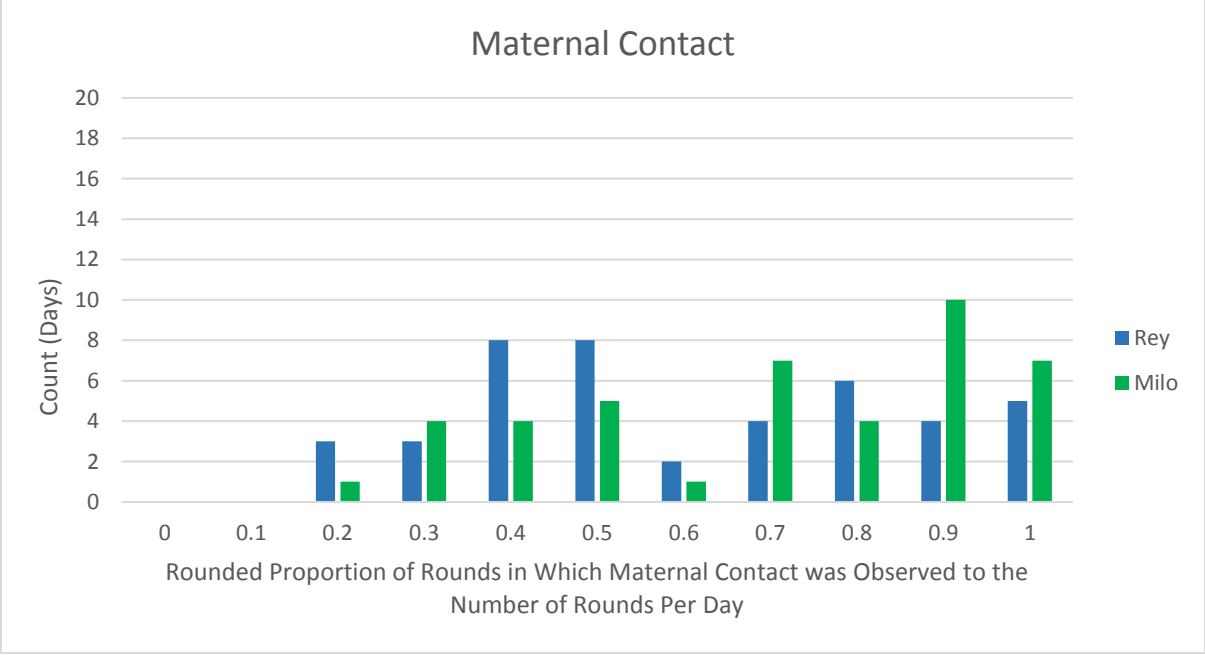

Figure 4: A comparison between Milo and Rey of their rounded proportions for rounds in which maternal contact was observed to the number of rounds per day. Milo has slightly more high proportions of maternal contact than Rey.

However, their averages for maternal proximity are similarly high and their averages for nursing are similarly low (Table 3). This is also reflected in the almost identical skews of their histograms (Figures 5 and 6).

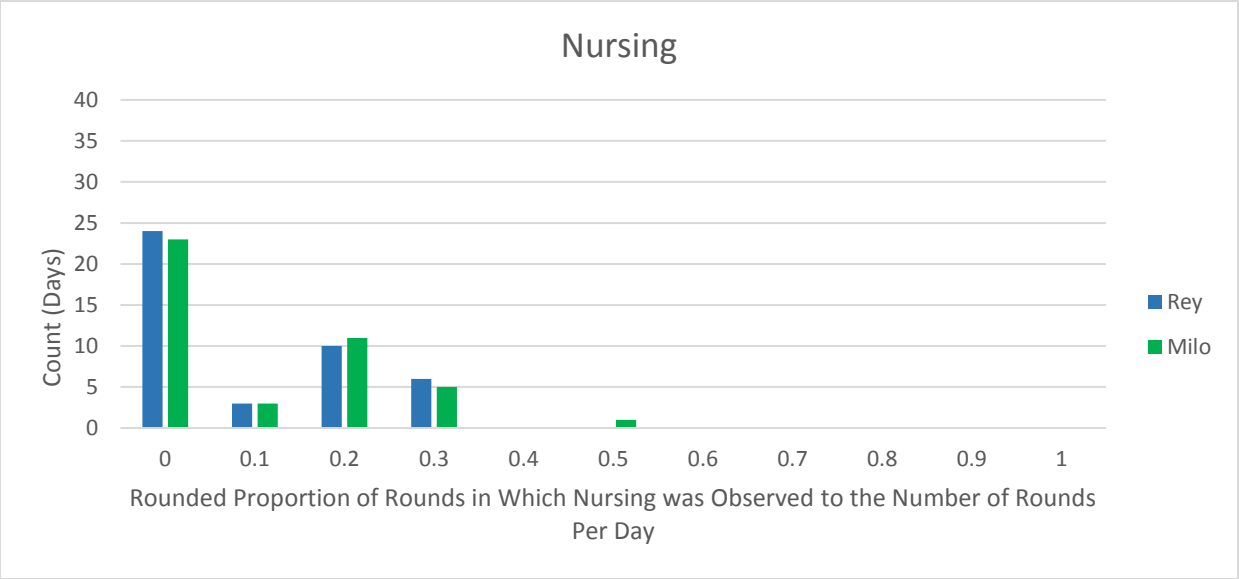

Figure 5: A comparison between Milo and Rey of their rounded proportions for rounds in which nursing was observed to the number of rounds per day. Proportions for both are skewed to the right.

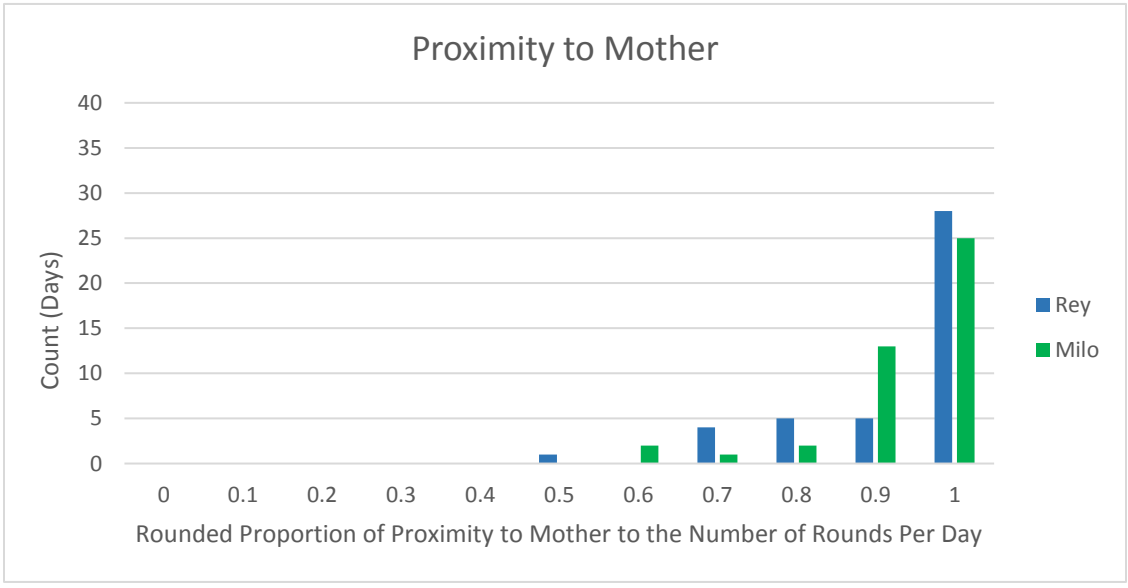

Figure 6: A comparison between Milo and Rey of their rounded proportions for rounds in which they were observed in proximity their mothers to the number of rounds per day. Proportions for both are highly skewed to the left.

Rey		Average (per day)
	Maternal Contact	0.580
	Nursing	0.078
	Proximity to Mom	0.913
Milo		
	Maternal Contact	0.674
	Nursing	0.086
	Proximity to Mom	0.923

Table 3: A table of descriptive statistics for maternal-related behaviors for Milo and Rey. Milo has a slightly higher average proportion of maternal contact, but their averages for maternal proximity are similarly high and averages for nursing are similarly low.

Discussion

Three predictions for infant behavior: differences in activity, maternal contact, and sociality, have little supporting evidence in the data. However, the data did appear to illustrate a similarity in proportion of feeding. Therefore, there is insufficient evidence for the null hypothesis to be rejected. Both Rey and Milo showed very low levels of feeding behavior throughout the study, and their averages were lower than all of the adults. However, this is to be expected since both infants were still nursing at the time. A similarity in feeding habits may reflect similar nutritional needs, and it may also support past research on silvered langur dentition. Previous studies have failed to show significant sexual dimorphism in silvered langur tooth development (Harvati, 2000). A similar dental eruption sequence would allow Milo and Rey to process and consume similar amounts of solid food.

The observations on infant activity, in contrast to the prediction, suggest that Rey was slightly more active than Milo. These results are in contrast with previous literature on Japanese macaques, which found that male infants are more active than females (Eaton *et al*, 1985). However, research on cercopithecines has produced contradictory evidence on sex differences in activity levels. This difference may simply be one of definition, in that some studies will focus on “play” or “exploration,” while “activity” is a bit more general (Bentley-Condit, 2003 and

Eaton *et al*, 1985). Sex differences in infant and juvenile activities, especially those regarded as "play," have also been extensively researched in different species of rats. These studies have broken down play behaviors even further into categories such as "locomotor play" and "play fighting." Male rats appear to engage in "play fighting" at a higher frequency than female rats, but there is no difference in "locomotor play" between the sexes (Pellis *et al*, 1997). Using more specific descriptions of behaviors may yield important sex differences in future research of infant silvered langur activity. In addition, the similarity in activity between Rey and Milo may be due to a lack of playmates. Previous studies on other species collected data on much larger groups of monkeys with more than two infants. A larger number of infants could have facilitated play differences between the two sexes (Nikolei and Borries, 1997). Rey and Milo only had each other as playmates, which could explain the similarity.

Another key difference between the results and predictions was the similarity in maternal contact between Rey and Milo. In fact, Milo had a slightly higher average for maternal contact. This finding disagrees with studies on Japanese macaques and olive baboons (*Papio anubis*) which found that mothers had more frequent contact with daughters than sons (Bentley-Condit, 2003 and Eaton *et al*, 1985). However, a later study on Japanese macaques examined maternal behavior independent of sex, and found that different mothers had different levels of interaction with their infants (Bardi and Huffman, 2001). The high proportions of maternal contact and maternal proximity for Rey and Milo may not be related to sex at all, but instead a product of similar maternal styles of Patty and Gumby.

Maternal contact also may explain the almost identically low grooming rates for Milo and Rey. Japanese macaque infants with more protective mothers also had lower amounts of social interaction with other group members (Bardi and Huffman, 2001). The low proportions of

grooming other group members for the infants may be a result of the high levels of maternal contact. However, an interesting result of the observations was that Thai had a lower average proportion of grooming than either of the mothers. He was also more active than both of the mothers. As previously stated, male silvered langurs almost always disperse from their natal group, while females usually stay in it. This was used to explain why young Hanuman langur female infants groomed more often than males, because the females need to start building relationships early (Nikolei and Borries, 1997). Perhaps there are differences in grooming rates and activity between male and female silvered langurs, but those differences only appear once the langurs have matured.

The close similarities between Rey and Milo in so many of the behaviors was the most surprising result of this study. Studies on other primate infants, even great apes, have found that sex differences in behavior are almost immediately apparent (Lonsdorf *et al*, 2013). These differences from previous literature highlight the need to further study infant behavior in colobines.

The one great caveat of this study is that behaviors are being compared in sample sizes of one. This makes statistical representation extremely limited and testing for significance almost impossible. These findings could be, for example, merely due to the personalities of each individual in the group. There have been dozens of papers on the intricacies and flexibility of primate personalities. However, of the some 350 known primate species, personality has only been rigorously studied in about 30 of them, of which the silvered langur is not included (Freeman and Gosling, 2010). This study serves as a basis for future research, such as in larger captive and wild groups of silvered langurs and other colobines. Such research into silvered langur behavioral development could be of great use in the future. Silvered langurs are plagued

by habitat deforestation, poaching, and the pet trade (Harding, 2010). Insight into how they develop may help zoos better understand how to raise them in conditions as close to the wild as possible.

Acknowledgements

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